NITROGEN AND PHOSPHORUS FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

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CORN

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied to optimize production of irrigated corn in western Kansas. In 2005, N and P applied alone increased yields about 60 and 11 bu/a, respectively; however, N and P applied together increased yields up to 142 bu/a. Averaged across the past 10 years, corn yields were increased up to 125 bu/a by N and P fertilization. Application of 120 lb N/a (with P) was sufficient to produce ~90% of maximum yield in 2005, which was slightly less than the 10-year average. Phosphorus increased corn yields in 2005 from 60 to 104 bu/a (average about 85 bu/a) when applied with at least 120 lb N/a. Application of 80 lb P_2O_5/a increased yields 2 to 22 bu/a compared to 40 lb P_2O_5/a when applied with at least 120 lb N/a.

Introduction

This study was initiated in 1961 to determine responses of continuous corn and grain sorghum grown under flood irrigation to N, P, and K fertilization. The study was conducted on a Ulysses silt loam soil with an inherently high K content. No yield benefit to corn from K fertilization was observed in 30 years and soil K levels remained high so the K treatment was discontinued in 1992 and replaced with a higher P rate.

Procedures

Initial fertilizer treatments in 1961 were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P_2O_5/a and zero K; and with 40 lb P_2O_5/a and 40 lb K_2O/a. In 1992, the treatments were changed with the K variable being replaced by a higher rate of P (80 lb P_2O_5/a). All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. The corn hybrids were Pioneer 3225 (1995-97), Pioneer 3395IR (1998), Pioneer 33A14 (2000), Pioneer 33R93 (2001 and 2002), DeKalb C60-12 (2003), and Pioneer 34N45 (2004 and 2005) planted at about 30-32,000 seeds/a in late April or early May. Hail damaged the 2005 and 2002 crop and destroyed the 1999 crop. The corn was irrigated to minimize water stress. Furrow irrigation was used through 2000 and sprinkler irrigation since 2001. The center 2 rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture.

Results

Corn yields in 2005 were slightly less than the 10-year average because of hail damage on August 19 (**Table 1**). Nitrogen alone increased yields up to 60 bu/a while P alone increased yields only about 11 bu/a. However, N and P applied together increased corn yields up to 142 bu/a. Only 120 lb N/a with P was required to obtain about 90% of maximum yields. Over the past 10 years, 120 lb N/a with P has produced about 95% of maximum yield. Corn yields were 5 bu/a greater with 80 than with 40 lb P_2O_5/a in 2005 which is consistent with the 10-year average. However, with N rates of 120 lb N/a or greater in 2005 the higher P rate increased yields about 10 bu/a.

Table 1. Effect of N and P fertilizers on irrigated corn. Tribune, KS, 1996-2005.

Nitrogen	P_2O_5	Grain Yield 1996	1997	1998*	2000	2001	2002	2003	2004	2005	Mean
- - - - lb/a - - - -		- bu/acre -									
0	0	58	66	49	131	54	39	79	67	49	66
0	40	64	79	55	152	43	43	95	97	60	77
0	80	73	83	55	153	48	44	93	98	51	78
40	0	87	86	76	150	71	47	107	92	63	87
40	40	111	111	107	195	127	69	147	154	101	125
40	80	106	114	95	202	129	76	150	148	100	125
80	0	95	130	95	149	75	53	122	118	75	101
80	40	164	153	155	205	169	81	188	209	141	163
80	80	159	155	149	211	182	84	186	205	147	164
120	0	97	105	92	143	56	50	122	103	66	93
120	40	185	173	180	204	177	78	194	228	162	176
120	80	183	162	179	224	191	85	200	234	170	181
160	0	103	108	101	154	76	50	127	136	83	104
160	40	185	169	186	203	186	80	190	231	170	178
160	80	195	187	185	214	188	85	197	240	172	185
200	0	110	110	130	165	130	67	141	162	109	125
200	40	180	185	188	207	177	79	197	234	169	179
200	80	190	193	197	218	194	95	201	239	191	191
ANOVA											
N		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P_2O_5		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.007	0.001	0.001	0.001	0.001
N x P		0.001	0.001	0.001	0.008	0.001	0.133	0.001	0.001	0.001	0.001
MEANS											
N, lb/a	0	65	76	53	145	48	42	89	87	53	73
	40	102	104	93	182	109	64	135	132	88	112
	80	139	146	133	188	142	73	165	178	121	143
	120	155	147	150	190	142	71	172	188	133	150
	160	161	155	157	190	150	71	172	203	142	156
	200	160	163	172	197	167	80	180	212	156	165
	$LSD_{0.05}$	10	12	11	10	15	8	9	11	10	6
P_2O_5, lb/a	0	92	101	91	149	77	51	116	113	74	96
	40	148	145	145	194	147	72	168	192	134	149
	80	151	149	143	204	155	78	171	194	139	154
	$LSD_{0.05}$	7	9	7	7	10	6	6	8	7	4

*Note: There was no yield data for 1999 because of hail damage. Hail reduced yields in 2002 and 2005.

GRAIN SORGHUM

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied to optimize production of irrigated grain sorghum in western Kansas. In 2003, N and P applied alone increased yields about 50 and 13 bu/a, respectively; however, N and P applied together increased yields more than 65 bu/a. Averaged across the past 10 years, sorghum yields were increased more than 50 bu/a by N and P fertilization. Application of 40 lb N/a (with P) was sufficient to produce >90% of maximum yield in 2003 and for the 10-year average. Application of K had no effect on sorghum yield in 2003 or averaged across all years.

Introduction

This study was initiated in 1961 to determine responses of continuous grain sorghum grown under flood irrigation to N, P, and K fertilization. The study was conducted on a Ulysses silt loam soil with an inherently high K content. The irrigation system was changed from flood to sprinkler in 2001.

Procedures

Fertilizer treatments initiated in 1961 were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P_2O_5/a and zero K; and with 40 lb P_2O_5/a and 40 lb K_2O/a. All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. Sorghum (Mycogen TE Y-75 from 1992-1996, Pioneer 8414 in 1997, and Pioneer 8500/8505 from 1998-2005) was planted in late May or early June. Irrigation was used to minimize water stress. Furrow irrigation was used through 2000 and sprinkler irrigation since 2001. The center 2 rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 12.5% moisture.

Results and Discussion

Grain sorghum yields were reduced by hail in 2005 and were less than the 10-year average (**Table 2**). Nitrogen alone increased yields up to 28 bu/a while P alone had no effect on yield. However, N and P applied together increased sorghum yields up to 50 bu/a. Averaged across the past 10 years, only 40 lb N/a has been required to obtain >90% of maximum yields. Sorghum yields were not affected by K fertilization, which has been the case throughout the study period.

Table 2. Effect of N, P, and K fertilizers on irrigated sorghum yields, Tribune, KS, 1996-2005.

N	P_2O_5	K_2O	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Mean
- - - - - lb/acre - - - -			- bu/acre -										
0	0	0	74	81	77	74	77	76	73	80	57	58	73
0	40	0	77	75	77	85	87	81	81	93	73	53	79
0	40	40	79	83	76	84	83	83	82	93	74	54	80
40	0	0	74	104	91	83	88	92	82	92	60	63	84
40	40	0	100	114	118	117	116	124	120	140	112	84	116
40	40	40	101	121	114	114	114	119	121	140	117	84	116
80	0	0	73	100	111	94	97	110	97	108	73	76	95
80	40	0	103	121	125	113	116	138	127	139	103	81	118
80	40	40	103	130	130	123	120	134	131	149	123	92	125
120	0	0	79	91	102	76	82	98	86	97	66	77	86
120	40	0	94	124	125	102	116	134	132	135	106	95	118
120	40	40	99	128	128	105	118	135	127	132	115	98	120
160	0	0	85	118	118	100	96	118	116	122	86	77	105
160	40	0	92	116	131	116	118	141	137	146	120	106	124
160	40	40	91	119	124	107	115	136	133	135	113	91	118
200	0	0	86	107	121	113	104	132	113	131	100	86	111
200	40	0	109	126	133	110	114	139	136	132	115	108	123
200	40	40	95	115	130	120	120	142	143	145	123	101	125
ANOVA (P>F)													
Nitrogen			0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear			0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic			0.116	0.001	0.001	0.227	0.001	0.001	0.001	0.001	0.018	0.005	0.001
P-K			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zero P vs P			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P vs P-K			0.727	0.436	0.649	0.741	0.803	0.619	0.920	0.694	0.121	0.803	0.688
N x P-K			0.185	0.045	0.186	0.482	0.061	0.058	0.030	0.008	0.022	0.195	0.018
MEANS													
Nitrogen	0 lb/a		77	80	76	81	82	80	79	88	68	55	78
	40		92	113	108	105	106	112	108	124	96	77	105
	80		93	117	122	110	111	127	119	132	100	83	113
	120		91	114	118	95	105	122	115	121	96	90	108
	160		89	118	124	108	110	132	129	134	107	92	116
	200		97	116	128	115	113	138	131	136	113	98	120
	$LSD_{0.05}$		9	10	8	13	7	8	9	10	11	10	7
P_2O_5-K_2O	0 lb/a		79	100	103	90	91	104	94	105	74	73	92
	40- 0		96	113	118	107	111	126	122	131	105	88	113
	40-40		95	116	117	109	112	125	123	132	111	87	114
	$LSD_{0.05}$		7	7	6	9	5	6	6	7	7	7	5